Eight-year sustainability of a successful intervention to prevent urinary tract infection: A mixed-methods study

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Abstract: BACKGROUND Data on long-term effects of interventions in infection control are scarce. We aimed to evaluate the 8-year sustainability of a successful intervention to reduce urinary tract infections (UTIs) through restriction of urinary catheter (UC) use in an orthopedic surgical population. METHODS Prospective UTI surveillance from November 2009-January 2010 was conducted to compare the results against the 2-year sustainability assessment performed in 2004. Semistructured staff interviews focused on UC indication, training, insertion techniques, and recall of the former intervention. RESULTS A total of 336 consecutive patients were included (median age, 63 years; range, 16-95 years; 55% women). A UC was placed in 17.6% of patients (operating room [OR], 10.1%; postanesthesia care unit [PACU], 3.6%; surgical wards [SW], 3.9%) compared with 20.0% in 2004 (OR, 15.7%; PACU, 1.0%; SW, 3.7%). The incidence rate of UTI was 2.4 per 1,000 patient-days in 2010 versus 2.6 per 1,000 patient-days in 2004; adjusted incidence rate ratio 0.76; 95% confidence interval, 0.21-2.76; P = .67. The qualitative inquiry demonstrated poor recall of the intervention and knowledge of guidelines except in the OR, where we identified a champion leader. DISCUSSION The intervention effect was sustained with regard to overall UTI rate and UC placement in the OR, but less in the PACU and SW. CONCLUSIONS Continuous leadership of a single opinion leader in a pivotal position can contribute critically to sustainability.

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Major Article

Eight-year sustainability of a successful intervention to prevent urinary tract infection: A mixed-methods study

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Infection control
Urinary catheterization
Quality improvement intervention

Background: Data on long-term effects of interventions in infection control are scarce. We aimed to evaluate the 8-year sustainability of a successful intervention to reduce urinary tract infections (UTIs) through restriction of urinary catheter (UC) use in an orthopedic surgical population.
Methods: Prospective UTI surveillance from November 2009-January 2010 was conducted to compare the results against the 2-year sustainability assessment performed in 2004. Semistructured staff interviews focused on UC indication, training, insertion techniques, and recall of the former intervention.
Results: A total of 336 consecutive patients were included (median age, 63 years; range, 16-95 years; 55% women). A UC was placed in 17.6% of patients (operating room [OR], 10.1%; postanesthesia care unit [PACU], 3.6%; surgical wards [SW], 3.9%) compared with 20.0% in 2004 (OR, 15.7%; PACU, 1.0%; SW, 3.7%). The incidence rate of UTI was 2.4 per 1,000 patient-days in 2010 versus 2.6 per 1,000 patient-days in 2004; adjusted incidence rate ratio 0.76; 95% confidence interval, 0.21-2.76; $P = .67$. The qualitative inquiry demonstrated poor recall of the intervention and knowledge of guidelines except in the OR, where we identified a champion leader.
Discussion: The intervention effect was sustained with regard to overall UTI rate and UC placement in the OR, but less in the PACU and SW.
Conclusions: Continuous leadership of a single opinion leader in a pivotal position can contribute critically to sustainability.

Health care-associated infections (HAIs) are the most common complications affecting hospitalized patients.[1] Urinary tract infections (UTIs) represent around 40% of all HAI, and a majority is attributable to indwelling urinary catheter (UC) use.[2-4] Therefore, UTI represent a prime target for HAI prevention.

We conducted a 3-phase, controlled, prospective before–after intervention study to reduce UTI among orthopedic surgery patients at the University of Geneva Hospitals. Restricting UC use to well-defined indications and promoting aseptic techniques were the main elements of the multifaceted intervention.[5] After a baseline assessment in 2001-2002, the intervention was implemented and its influence assessed in 2002 and 2004. As a matter of fact, this was

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Preliminary results of this study were presented as posters at the European Conference on Clinical Microbiology and Infectious Diseases 2012, London, United Kingdom (abstract P1357) and the annual meeting of the Swiss Societies for Infectious Diseases and Hospital Hygiene 2012, St Gallen, Switzerland (abstract P13).
Conflicts of Interest: None to report.

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among the unique UTI intervention studies using a concurrent control group.[6] The incidence of UTI following orthopedic surgery decreased by two-thirds when compared with the control group, and its benefit persisted over 2 years. The results demonstrated that a multifaceted prevention strategy can substantially decrease UTI in this population and contribute to the reduction of the overall use of antibiotics after surgery.[5]

Little is known about the sustainability of such interventions over longer time periods.[7] In the present study, we assessed the 8-year sustainability of the original 2001-2002 intervention with regard to UC use and UTI rate and evaluate collective recall of the intervention, knowledge of institutional guidelines, and risk perception among health care professionals.

MATERIALS AND METHODS

Setting

The University of Geneva Hospitals serve a population of 800,000 as a primary and tertiary care center with approximately 2,000 beds and 47,000 admissions per year. The orthopedic surgery department consists of 5 wards with 150 beds. Approximately 40% of all annual orthopedic interventions (n = 5,000) are elective.

Study design and procedures

The original intervention in 2001-2002 focused on perioperative UC management.[5] We used a multifaceted intervention that combined specifically tailored, locally developed guidelines, education sessions, and posters showing a visual display of specific guidelines. The guidelines defined criteria for the placement and management of UC in the operating room, postanesthesia care unit, and surgical wards.

The quantitative part of the current investigation consisted of a prospective, observational study to monitor UTI incidence using the same surveillance methodology as the original study, including selection of variables, definitions, and sample size calculations.[5] All adult patients undergoing elective orthopedic surgery between November 16, 2009, and January 29, 2010, were eligible for inclusion. Data were extracted from nursing records, anesthesia data sheets, and paper and electronic patient records and entered into a customized electronic database (FileMaker Pro version 8.0; Filemaker, Inc, Santa Clara, CA). In addition, an infectious disease physician (HS) visited the orthopedic wards twice a week to evaluate study patients for UTI and UC use. The dataset of the original study was used to compare the current 8-year sustainability time point against the 2-year sustainability assessment in 2004.[5]

For the qualitative part, we conducted short semistructured individual interviews with conveniently chosen health care workers without previous appointment during 7 informal visits in the 3 study locations using a diversity probing sampling strategy from a large population of more than 500 health care workers: operating room, postanesthesia care unit, and surgical wards. One of the 2 interviewers (YA and RR) took notes while the other explained briefly the project and conducted the interview. Typical interview guide questions are listed in Table 1. Analysis consisted in the extraction of the emerging themes from all interview notes using a grounded theory approach.[8] Thematic triangulation among interviewees was applied to select the major themes for this report.

Table 1
Interview guide

1) Can you please enumerate the indications for urinary catheter use? If you were unsure about indications, where would you look for more information to make a decision for a given patient?
2) Do you remember any intervention related to this topic in this hospital?
3) Do you remember when and where you received the teaching for urinary catheter insertion and care? What made you adopt the technique you are currently using?
4) What is your view concerning asepsis during catheter handling in this hospital?
5) Do you have any suggestions on how to improve catheter care or reduce urinary tract infection in your work environment?

Definitions

UTI was defined according to the Centers for Disease Control and Prevention.[9] The UTI incidence refers to the number of new cases of UTI per 100 patients. The device-associated incidence rate refers to the number of new episodes of infection per 1,000 urinary catheter-days. Catheter-associated UTI (CAUTI) corresponded to an episode of UTI in the presence of an indwelling UC within an 48-hour period before the onset of UTI.[9]

Statistical analysis

Differences in means and medians were compared using the Student *t* test and the Wilcoxon rank-sum test, respectively.

We used univariable and multivariable logistic regression analyses to evaluate differences in the proportion of patients with UTI and Poisson regression methods to assess differences in UTI incidence rates and device-associated incidence density between follow-up periods, respectively. Potential confounders from patient, patient management, and UC management characteristics with P values < .1 in univariable analyses were considered for inclusion in multivariable models based on clinical judgment, with final models representing those that best balanced parsimony and fit. The limited number of outcomes was factored in when building the models to prevent overfitting.[10]

Data were analyzed using Stata version 12.1 (Stata Corp, College Station, TX) and SAS version 9.1 (SAS Institute Inc, Cary, NC). P values < .05 were considered statistically significant.

Ethics approval

The institutional review board approved the study as a continuous quality improvement project; therefore, no informed consent was required.

RESULTS

Of 344 patients fulfilling the inclusion criteria, 8 were excluded due to missing information about catheterization status, leaving 336 patients for final analysis. Patient characteristics and UC management parameters are shown in Tables 2 and 3, respectively.

Quantitative approach

Urinary catheterization

Detailed results regarding urinary catheterization are listed in Table 3. We observed no change in the overall proportion of catheterized patients compared with the 2-year follow-up (20.0% vs 17.6%; P = .43). There was no change in the UC use ratio. Although

Table 2
Patient and patient management characteristics

Variable	Preintervention (n = 280)	Postintervention (n = 259)	2-y Follow-up (n = 300)	8-y Follow-up (n = 336)	*P* value*
Age, y	62.5 (16-97)	62.0 (17-93)	62.0 (16-98)	63.0 (16-95)	.51
Male sex	132 (47.1)	113 (43.6)	149 (49.7)	150 (44.6)	.21
Body mass index	25.1 (13.1-50.7)	24.8 (11.4-41.4)	25.5 (12.7-57.2)	26.0 (15.6-53.4)	.43
Obesity (body mass index ≥ 30)	64 (22.8)	53 (20.5)	69 (23.0)	72 (22.1)	.78
ASA class > 2	76 (27.0)	56 (22.0)	61 (20.3)	69 (20.5)	.95
Diabetes mellitus	29 (10.3)	26 (10.0)	32 (10.7)	38 (11.3)	.80
Immunosuppression	7 (2.5)	5 (1.9)	12 (4.0)	4 (1.2)	.033
Malnutrition	2 (0.7)	5 (1.9)	8 (2.7)	3 (0.9)	.10
Procedures					
Total hip replacement	72 (26.0)	68 (26.2)	80 (26.7)	66 (19.6)	.036
Total knee replacement	42 (15.0)	29 (11.2)	46 (15.3)	56 (16.7)	.65
Lower limb surgery	42 (15.0)	32 (12.4)	46 (15.3)	51 (15.2)	.96
Foot surgery	45 (16.0)	52 (20.0)	37 (12.3)	67 (19.9)	.010
Upper limb surgery	33 (11.8)	37 (14.3)	39 (13.0)	29 (8.9)	.08
Removal of orthopedic material	23 (8.2)	29 (11.2)	37 (12.3)	24 (7.1)	.028
Miscellaneous	23 (8.2)	12 (4.6)	15 (5.0)	43 (12.8)	.001
Duration of surgery, min	100 (15-480)	110 (20-480)	90 (10-540)	96 (11-307)	.76
Anesthesia techniques					
General anesthesia with and without nerve blocks	163 (58.2)	157 (60.6)	188 (63.0)	242 (72.0)	.012
Spinal or epidural anesthesia with and without peripheral nerve blocks	57 (20.3)	38 (14.7)	44 (14.7)	30 (8.9)	.026
General plus spinal or epidural anesthesia	4 (1.4)	4 (1.5)	6 (2.0)	1 (.3)	.08
Peripheral nerve blocks	56 (20.0)	60 (23.2)	62 (20.7)	63 (18.7)	.54
Volume infusion, mL	1,200 (100-5,250)	1,200 (220-8,500)	1,200 (100-8,000)	1,000 (1,000-4,000)	.003
Length of stay, d	12 (1-167)	11 (2-107)	11 (1-161)	9 (1-102)	< .001

NOTE. Values are presented as median (range) or n (%).
BMI, body mass index; *ASA*, American Society of Anesthesiologists.
*2-year follow-up versus 8-year follow-up.

Table 3
Urinary catheter management

Variable	Preintervention (n = 280)	Postintervention (n = 259)	2-y Follow-up (n = 300)	8-y Follow-up (n = 336)	*P* value*
Urinary-bladder management in OR					
Initial urinary catheterization	88 (31.5)	62 (24.0)	47 (15.7)	34 (10.1)	.037
Intermittent catheterization	1 (0.4)	1 (0.4)	0 (0)	0 (0)	n.a.
Preexisting long-term urinary catheterization in OR	15 (5.4)	17 (6.5)	15 (5.0)	6 (1.8)	.030
Bladder ultrasound examination in PACU	28 (10.0)	21 (8.1)	4 (1.7)	8 (2.4)	.53
Urinary catheterization in PACU†	4 (1.4)	8 (3.0)	3 (1.0)	12 (3.6)	.046
Urinary catheterization in surgical ward†	7 (2.5)	9 (3.5)	11 (3.7)	13 (3.9)	.89
Duration of catheterization‡, d	3 (1-25)	3 (1-31)	4 (1-56)	5 (1-35)	.07
Urinary catheterizations ≤ 3 d	50 (51.5)	49 (68.1)	25 (43.9)	15 (25.9)	.05
Urinary catheter use ratio§	14.2	14.7	12.2	11.2	.19

NOTE. Values are presented as n (%) or median (range) unless otherwise noted.
n.a., not available; *OR*, operating room; *PACU*, postanesthesia care unit.
*Two-year follow-up versus 8-year follow-up.
†Includes indwelling urinary catheter and intermittent catheterization.
‡Patients with ongoing long-term urinary catheterization were excluded.
§Urinary catheter-days/100 patient-days.

the frequency of UC insertion decreased in the operating room, it increased significantly in the postanesthesia care unit (Table 3). We observed no change in the proportion of patients exposed to UC between the 2 follow-up periods.

UTI rates

In comparison with the 2004 follow-up assessment, there was no change in the proportion of patients with UTI (adjusted odds ratio [aOR], 0.36; 95% confidence interval [CI], 0.08-1.59), the UTI incidence rate (aOR, 0.76; 95% CI, 0.21-2.76), and the device-associated incidence density (aOR, 0.51; 95% CI, 0.15-1.73). Variables retained in these multivariable models to adjust for population differences were: urinary catheterization, UC days, volume of infusion, initial UC in the operating room, and miscellaneous surgical interventions for UTI incidence; urinary catheterization, miscellaneous surgical interventions, UC days, initial UC in the operating room, and volume of infusion for incidence rate; and urinary catheterization and prosthetic material removal for device-associated incidence rate (Supplemental Table S1). Crude trends in UTI infection rates are shown in Table 4.

Only 2 out of 9 UTIs (22.2%) recorded in the present study period were associated with a UC; that is, CAUTI, and only 4 out of 9 (44.4%) patients were ever exposed to a UC before UTI. As a result, the proportion of patients affected by CAUTI was 0.5% and CAUTI incidence rate was 0.5 per 1,000 patient-days and 4.8 per 1,000 catheter-days.

Qualitative approach

We interviewed 4 anesthesiologists and 1 nurse in the operating room, 7 nurses and 1 medical student in the postanesthesia care unit, and 4 nurses and 1 physician in surgical wards. Overall, 5 prominent themes were identified:

1. *Collective memory of the intervention.* All but 2 interviewees—who had mostly joined the institution during the past few years—

Table 4
Urinary tract infections (UTIs)

	Preintervention	Postintervention	2-y Follow-up	8-y Follow-up	*P* value*
UTI	29 (10.4)	10 (3.9)	11 (3.7)	9 (2.7)	.48
UTI per 1,000 patient-days	6.5	2.7	2.6	2.4	.89
UTI per 1,000 catheter-days	45.8	18.6	21.2	21.6	.96

NOTE. Values are presented as n (%).
*Two-year follow-up versus 8-year follow-up.

did not remember the intervention. The only person who exactly recalled and still championed the original approach was the attending anesthesiologist in the operating room. We found the original poster display of the indications for UC insertion still hanging on the wall of the anesthesia induction room but, surprisingly, 1 interviewee standing right next to it confirmed never having seen it.

2. *Indication*. The indications for UC placement as defined by the intervention were not clearly present in overall workers' memory. For female patients, pain during postoperative mobilization and "hygiene" were often mentioned as motivation for catheterization and which patients themselves frequently requested.
3. *Insertion technique.* In practice, the insertion methods were not reliably carried out according to the institutional standard operating procedures. Health care workers did not have formal inhouse training. Their skills were acquired during nursing and physicians' education and adapted by observation of peers and through a culture of oral transmission.
4. *Shared ownership.* Prescription of urinary catheterization was the responsibility of physicians. However, they usually relied on nurses to raise the issue.
5. *Disrupted information flow.* The transmission of information about the indication for urinary catheterization between the postanesthesia care unit and the surgical wards during patient transfer was regarded as insufficient, leading to delays in catheter removal.

DISCUSSION

At 8-year follow-up, assessing the sustainability of a previously successful intervention to reduce UTIs through restriction of UC use in an orthopedic surgical population, we demonstrated a sustained low UTI incidence despite a marked diminution in the knowledge of the initial program components among health care workers, as suggested by the qualitative inquiry. This sustained effect was in large part the result of the influence of an attending physician leading anesthesia operations in the orthopedic surgical wards who championed the idea of restrictive UC use.

There is still little and insufficient evidence to determine which interventions for prevention of device-related infections are most effective in changing professional behavior,[11] and even less is known about factors promoting sustainability of such intervention programs. Sustainability can be defined as "the continued use of program components and activities for the continued achievement of desirable program and population outcomes."[12] It has been found that the likelihood of sustainability is heightened when the program concerns a topic recognized by the larger public around the organization and is in line with the aims and capacities of the organization.[12] Accordingly, there are several possible explanations for the sustainability of outcome effects in our study. First, it could actually reflect a true long-lasting effect of the original intervention in terms of sustained change in practice that was passed down to other health care workers through word of mouth and observation of peers. Second, awareness of HAIs in general and the role of invasive devices as an important avoidable risk factor may have increased among all health care workers over recent years due to ongoing promotional efforts and media coverage. Of note, a large institutional program to prevent central vascular catheter infections was ongoing in parallel to this study.[13,14] Third, the constant presence of a champion who strongly supported the importance of UTI prevention was sufficient to maintain the restricted use of UCs preoperatively. There is evidence that this latter hypothesis has a strong case: The rate of UC use decreased further in the operating room but not elsewhere, and neither the indications for catheterization nor the intervention as such was recalled by the interviewees. It might be pivotal that this person is present at the leverage point in the process, has a strong personality, and is in an assigned leadership role. The successful implementation of the program in 2001 using a proactive multifaceted approach led by a multidisciplinary team laid the groundwork for this project.

Eight years of follow-up represent an exceptionally long period of sustainability assessment in the literature on infection control and patient safety. The lack of similar reports is probably due to the financial pressure under which quality improvement efforts and scientific studies usually operate. Moreover, in today's large teaching institutions, the leaders of an intervention often leave the institution or rotate to different positions at short intervals. Unsurprisingly also in this case, the operational members of the research team left shortly after the completion of the original study.

The qualitative inquiry was instrumental in explaining the results and elucidating the culture of urinary catheterization practices in the different hospital sectors. To include qualitative inquiry in epidemiologic evaluations has been advocated as beneficial by others.[15-17] Thereby, 2 fields for future improvement were identified. First, the insertion technique does not seem to be standardized despite an existing written protocol, apparently unknown by most. The hospital does not provide a formal mandatory training for this task. The second point concerns the addressed lack of written information concerning the original indication for the UC at patient handover from the postanesthesia care unit to the wards. Interviewees revealed that the ambiguity surrounding preexisting patient conditions that would justify long-term catheterization might undermine timely removal after patient arrival in surgical wards. This could easily be fixed by introducing this item on the handover checklist.

It might come as a surprise that only 2 of the 9 identified UTIs were catheter-associated according to the 48-hour Centers for Disease Control and Prevention definitions for this association.[18] Even with the more sensitive definitions of a 7-day latency proposed by the European Centers for Disease Control and Prevention,[19,20] not more than half of UTIs were catheter-associated. Although UCs represent the single most important identifiable risk factor for UTI, not all UTIs are CAUTI.[4]

The study has several limitations. First, because length of hospital stay decreased over time, and because only in-hospital UTIs were assessed, the UTI rate might have been underestimated because some UTIs may have occurred after discharge. However, this effect may be compensated for by the fact that a shorter length of stay will decrease the risk of HAI through shorter risk exposure. Furthermore, differences in patient populations over the years might represent an alternative explanation for the sustainability effect. Yet, adjustment for the most plausible confounding factors in a multivariable model did not influence the results. Finally, selection bias may have played a role in choosing the subjects for the qualitative interviews. Triangulation was strong among interviews, which indicates sampling saturation. Last, because this was a single-center study in 1 surgical specialty, results may not be generalizable to other surgical specialties or geographic areas.

CONCLUSIONS

We were able to demonstrate that a multifaceted intervention targeting perioperative UC management for orthopedic surgery patients may be sustained over as long as 8 years. An important driver for sustainability was a single champion opinion leader at a leverage point of the system. More studies on sustainability with follow-up times of 5-10 years or more are warranted to increase insight in this area of implementation science and infection prevention.

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APPENDIX: SUPPLEMENTARY MATERIAL

Supplementary data to this article can be found online at doi:10.1016/j.ajic.2016.01.013.

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